March 9, 2004

CORPS SPILL CHANGE GUIDANCE
For Columbia and Snake Rivers

1. **BiOp Guidance:** The 2000 Biological Opinion has a table that provides spill levels and gas caps as guidance to spill changes. This table is shown below and is called Table 9.6-3 (on Page 9-89) Estimated spill levels and gas caps for FCRPS projects during spring (all) and summer (non-transport) projects provides guidance on spill requirements. Since the spill levels and gas caps established in Table 9.6-3 as part of the BiOp, they are some of the most important tools in our spill adjustments.

   It contains several items that specifically effect spill levels:
   a. Limiting Factors: gas cap, % of river flow (JDA-60% at night, TDA 40% of instantaneous flow), and minimum spill at BON of 75 kcfs.
   b. Daytime spill schedule: The definition of daytime and nighttime effects how long the spill levels are maintained. (BON – night is from 2130 to 0500 during July and Aug. See Fish Passage Plan, Bon-13, Table Bon -6)

Table 9.6-3. Estimated spill levels and gas caps for FCRPS projects during spring (all) and summer (nontransport projects).

Project[1]	Estimated Spill Level[2]	Hours	Limiting Factor
Lower Granite	60 kcfs	6 p.m. - 6 a.m.	gas cap
Little Goose	45 kcfs	6 p.m. - 6 a.m.	gas cap
Lower Monumental	40 kcfs	24 hours	gas cap
Ice Harbor	100 kcfs (night) 45 kcfs (day)	24 hours	nighttime - gas cap daytime - adult passage
McNary	120-150 kcfs	6 p.m. - 6 a.m.	gas cap
John Day	85-160 kcfs/60% [3] (night)	6 p.m. - 6 a.m.[4]	gas cap/percentage
The Dalles	40% of instant flow	24 hours	tailrace flow pattern and survival concerns (ongoing studies)
Bonneville	90-150 kcfs (night) 75 kcfs (day)	24 hours	nighttime - gas cap daytime - adult fallback

[1] Summer spill is curtailed beginning on or about June 20 at the four transport projects (Lower Granite, Little Goose, Lower Monumental, and McNary dams) due to concerns about low inriver survival rates.
[2] Estimated spill levels shown in the table will increase for some projects as spillway deflector optimization measures are implemented.
[3] The TDG cap at John Day Dam is estimated at 85 to 160 kcfs, and the spill cap for tailrace hydraulics is 60%. At project flows up to 300 kcfs, spill discharges will be 60% of instantaneous project flow. Above 300 kcfs project flow, spill discharges will be at the gas cap (up to the hydraulic limit of the powerhouse).
[4] Spill at John Day Dam will be 7:00 p.m. to 6:00 a.m. (night) and 6:00 a.m. to 7:00 p.m. (day) between May 15 and July 31.

The Biological Opinion effective spill levels for several projects described above were modified by the results of recent fish tests. The following is the modified spill regime that will be used during the 2004 spill season:

- John Day: From April 10 to July 20, 60% of instantaneous project flow at project flows up to 300,000 cfs will be spilled or to the gascap. Above 300,000 cfs project flow, 180,000 cfs or up to the gascap will be spilled. As table 9.6.3 shows, the Biological Opinion established spill to occur for 12 hours nightly, from 1800 to 0600 hours. This was changed so that between May 15 and July 20, spill will occur from 1900 to 0600 hours (11 hours total). From July 21 through August 31, spill will be 30% of instantaneous project flow 24-hours per day or up to the gascap

- Lower Monumental: Spill at Lower Monumental will occur from 3 April through 20 June. Spill will consist of 45% to 50% of total river flow up to the gas cap of 34 kcfs 24-hours per day, depending upon total river flows. For total river flows below 75 kcfs and above 100 kcfs, spill will be 50% of total river flow. For total river flows between 75 kcfs and 100 kcfs, spill will be 45% of the total river flow. BPA has specified 11.5 kcfs as minimum powerhouse flow for system reliability. When the seasonal average regulated flow at Lower Granite Dam is projected to be less than 85 kcfs, no spill shall occur at Lower Monumental Dam, unless the TMT recommends that spill occur.

- Lower Granite: Spill at Lower Granite dam will occur from 3 April through 20 June and will consist of two separate regimes: Removable Spillway Weir (RSW) spill and BiOp spill. The RSW spill regime will total about 19 kcfs for 24 hours per day (7 kcfs passing through the RSW unit with 12 kcfs of training spill through other spillway bays). BiOp spill will be up to the gas cap of 40 kcfs during nighttime hours (1800 to 0600 hours). Over the entire season, 50% of the days will be RSW spill and the other 50% will be BiOp spill. BPA has specified 11.5 kcfs as minimum powerhouse flow for system reliability. When the seasonal average regulated flow at Lower Granite Dam is projected to be less than 85 kcfs, no spill shall occur at Lower Granite Dam, unless the TMT recommends that spill occur.

2. **Oregon Variance and Washington Rule Change:** The State variances establish TDG limits of 115% for the forebay and 120% for tailwater. In order to address the requirements of the variances, the Corps tracks the following information:
    a. High 12-Hour TDG Average: Since the TDG high 12-hour average is what the Corps is legally required to comply with for the variance, it is one of the most important tools we use to assess how well we did on our spill adjustments. The summary of the high 12-hour TDG averages is listed as 12hrAvg at http://www.nwd-wc.usace.army.mil/tmt under the Water Control data. This is the external website for the public. There is an internal website with the same information plus 12 hour averages calculated for Libby, Chief Joseph and Albeni Falls gages that can be found at **https://npr71.nwd-wc.usace.army.mil/rccweb/rccgas/12hr/html/.** These high 12-hour daily averages are reviewed daily. New data comes in every four hours into the CWMS database and this program calculated the average every hour with the data.

b. Daily TDG Spill Decisions: The Corps fills out daily TDG spill decision documents with the numeric data of project forebay and tailwater and our comments from daily reviews, which are put in a Spill Log. The spill decision information is entered into a database. An example of the information entered is shown

c. Exceedences Tracking: The Corps keeps track of the date, number, reason and actions taken for the exceedences that occur. The exceedence tracking summary is discussed at the TMT meeting and available on the TMT web page at http://www.nwd-wc.usace.army.mil/tmt/documents/ops/spill/

d. Amount of Voluntary Spill: The Corps keeps track of the amount of voluntary spill that represents Biological Opinion spill for fish.

3. Firm Generation Commitments

The various projects are entitled to a certain amount of flow for power generation at all times. The following table is a list of the flows associated with firm generation commitments.

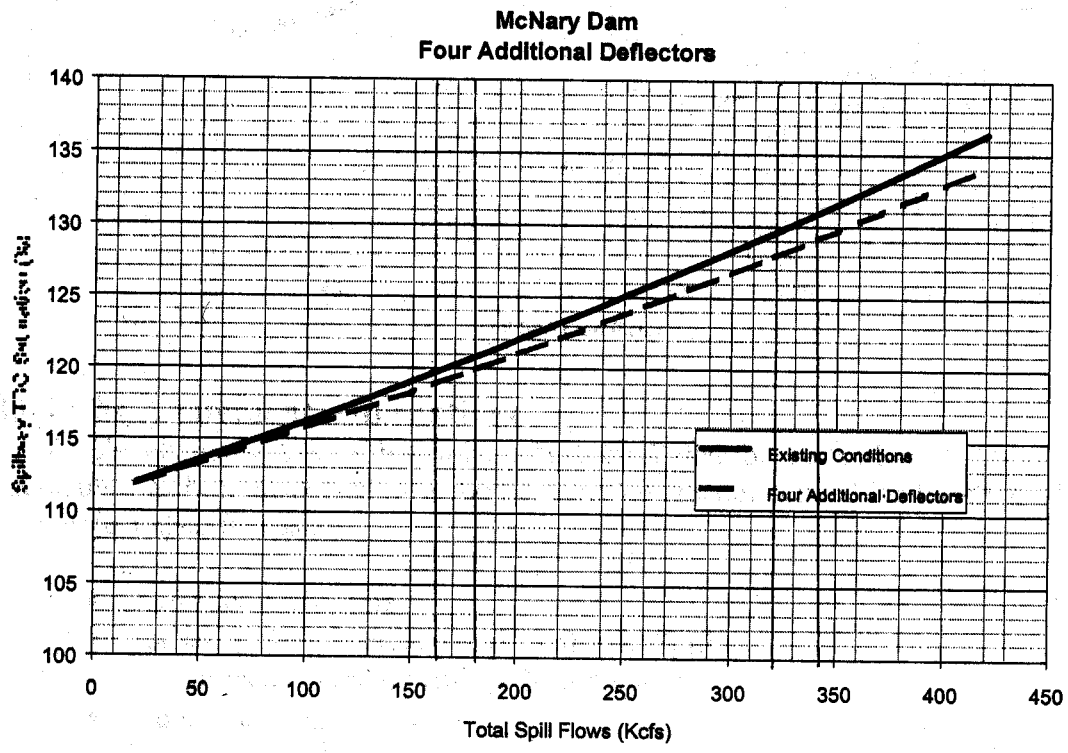
Firm Generation Commitments Flows

Project	Flows in kcfs
Lower Granite	11.5
Little Goose	11.5
Lower Monumental	11.5
Ice Harbor	11.5
McNary	50
John Day	50
The Dalles	50
Bonnesville	30

4. Basic Adjustment Guidance: The following basic adjustment guidance is a rule-of-thumb used in a general way.

a. Snake projects – 5 kcfs change results in about 2% change in TDG.
b. Columbia projects – 10 kcfs change results in about 2% change in TDG.
c. SYSTDG guidance for BON (with new deflectors on bays 1-3 and 16-18) Graphics based on variable spill levels based on variable inflowing TDG. (Example graph for inflow to BON at 112% provided, shown as Fig. 10)

5. **DGAS Report Project-by-Project Guidance**, There are 60% DGAS Report. Project TDG Performance Graphs that provide the relationship between spill flows and TDG levels. The following graph is an example. (Use existing conditions)



6. **Travel Time Guidance:** The following tables provide estimated travel times for water to travel from one project to the next on the Columbia and Snake Rivers.

COLUMBIA/SNAKE RIVER TRAVEL TIMES Days for Water to Travel through Reservoirs							
	VARIABLE RIVER FLOW RANGES						
PROJECT	50K*	75K**	100K*	150K**	200K*	250K**	300K*
From the Confluence of the Snake and Clearwater Rivers to Lower Granite Dam	4.23	3.29	2.35	1.692	1.034	0.8695	0.705
From RM 146.5 (Six miles up the Snake River and the beginning of the Lower Granite	4.5	3.5	2.5	1.8	1.1	0.925	0.75
From Lower Granite to Little Goose	5	3.9	2.8	2.15	1.5	1.25	1
From Little Goose to Lower Monumental	4.5	2.75	1	0.9	0.8	0.65	0.5
From Lower Monumental to Ice Harbor	4	3	2	1.5	1	0.8	0.6
From Ice Harbor to McNary	----	----	7	5.25	3.5	2.9	2.3
From McNary to John Day	----	----	0.4	0.8	1.2	1.4	1.6
From John Day to The Dalles	----	----	1.5	1.15	0.8	0.65	0.5
From The Dalles to Bonneville	----	----	4	3	2	1.7	1.4
From Bonneville to Camas/Washougal	----	----	1.**	.8***	0.6***	0.56***	0.49***

*Based on Figure A-2 from NITROGEN (GAS) SUPERSATURATION and related data analysis and interpretation, Lower Columbia and Lower Snake Rivers. Peter Boyer. Pacific Division, Corps of Engineers, Portland, Oregon. March 1974.

** Information on 75K, 150 K and 250 K flows was obtained by extrapolation between the informaiton given for flows.

*** These are estimated theoretical retention times based on information from Mike Schneider.

In order to know the travel time for water to flow from Dworshak to Lower Granite, it is necessary to calculate it in two parts and add them together. The two parts are the travel time from Dworshak to the confluence of the Snake River and the travel time from the confluence of the Snake River to Lower Granite. The following two tables show the information used to get the travel time for the Dworshak to Lower Granite reach.

DWORSHAK TO CONFLUENCE RIVER TRAVEL TIMES						
Days for Water to Travel through Reservoirs						
PROJECT	VARIABLE RIVER FLOW RANGES					
	5K*	10K**	20K*	30K**	40K*	50K**
From Dworshak Dam to Confluence of the Snake and Clearwater Rivers	19 hrs	15.6 hrs	12.6 hrs	11.1 hrs	10.2 hrs	9.5 hrs
From Dworshak Dam to Confluence of the Snake and Clearwater Rivers	0.79	0.65	0.53	0.46	0.43	0.40

Note: These are estimated theoretical retention times based on information from Mike Schneider.

DWORSHAK TO LOWER GRANITE RIVER TRAVEL TIMES						
Days for Water to Travel through Reservoirs						
PROJECT	VARIABLE RIVER FLOW RANGES					
	50K on Snake & 5K on Clearwater	75K on Snake & 10K on Clearwater	100K on Snake & 20K on Clearwater	150K on Snake & 30K on Clearwater	200K on Snake & 40K on Clearwater	250K on Snake & 50K on Clearwater
From Dworshak Dam to Lower Granite Dam	5.02	3.65	2.53	1.96	1.43	1.20

7. **Weekend Guidance:** Total River Flow can significantly decrease on weekends, causing a resulting increase in TDG if the Friday spill level is not changed.

8. **Monday Guidance**: Beginning-of-the-Week Total River Flows on Monday increase, causing the TDG level to decrease.

9. **Holiday Guidance**: same as weekend guidance.

10. **Degassing Guidance**:
    a. Winds above 10 mph enhance degassing in Columbia Gorge.
       http://www.wunderground.com/US/OR/Hood_River/KDLS.html
       Go to Personal Weather Station: Hood River (near bottom of the webpage)
    b. At flows **above** 200 kcfs at BON, little degassing occurs between BON and Camas.
    c. At flows **below** 200 kcfs at BON, significant degassing occurs between BON and Camas.

11. **Water Temperature Guidance**: Climatic conditions can cause increases in water temperatures, which in turn can cause increases in TDG levels. The rule of thumb is 1^{o}C or 1.8^{o}F water temperature increase can result in a 2 to 3 % increase in TDG saturation (based on the Boyle's gas law). Since we cannot predict water temperature, we use air temperature as found in weather forecast, as a surrogate. The National Weather Service, the Northwest River Forecast Center post information daily on the forecasted temperatures, which are available at http://137.161.65.209/weather/10_day.cgi.

12. **Spill passage test schedules:** The tests that are planned for each spill season is discussed in the Fish Passage Plan, Appendix A and in the Spring Summer Update of the Water Management Plan. When there are fish or spill passage tests, the test schedules incorporated changes in spill that can cause the mass of TDG in the river to fluctuate. The tests for the 2004 spill season are:

    - Lower Granite: Fish passage test where the behavioral guidance structure (BGS) is moved in front of the powerhouse while spill is at RSW plus 12 kcfs (about 19kcfs).
    - Lower Monumental: Test of the spill patterns under two conditions: bulk spill to the BiOp levels or bulk spill to the gas cap. Test spans from 4/15/04 through 6/30/04.
    - Ice Harbor: Fish passage test where the spill will fluctuate between gascap and 45 kcfs. Spill at Ice Harbor will occur from 3 April through 31 August and will consist of two separate regimes. One regime, which will occur about 50 percent of days, will consist of spill of 45 kcfs for 24-hours. For the other 50% of days, spill will be to the gas cap of 92 kcfs for 24 hours.

13. **Maintenance and Repairs**: maintenance or repairs of units limit the amount of spill that can occur through them. An example is Lower Granite on 6/17/2002 to 6/21/2002 when the project operator requested that spill level be limited to 35 KCFS during diving operations for deployment of RSW.

14. **Physical Designs**: The physical design of each spillway causes specific spill characteristics for specific flow ranges. They are identified in the annual Fish Passage Plan for Corps of Engineers Projects in tables called Spill Patterns.
    - John Day Spill Pattern – The spill patterns at John Day are such that to spill at low levels (80 KCFS) generate the same amount of TDG as spill at high levels (140 KCFS). Spill at about 120 KCFS generate much higher TDG levels than at 80 or 140 KCFS. This anomaly causes difficulty in regulating spill levels.
    - Bottlenecks in the Rivers: – The flow deflectors at certain projects allow higher spill levels than in the past. But as a result, certain projects become bottlenecks in segments of the river. For example, if Warrendale were operated at 120% then Camas/Washougal would be in exceedance of the 115% TDG gas cap most of the time when the total river flow is above 200 Kcfs. Similar phenomena occur at Lower Granite, Little Goose and Lower Monumental river segments in the Snake. If Little Goose is operated at 120% then Lower Monumental forebay would be in exceedance of the 115% TDG gas cap most of the time.

- Spillwall at The Dalles: During 2003 a spillwall was installed between bays 6 and 7 to direct the spill and fish into the main section of the river to avoid the lateral flows that exist. As a result, the spillwall will effect the spill pattern and the TDG levels.

15. **Physical Limitations:** There are two physical limitations that effects how the fish move and how spill can flow and.
    - **Screen Lengths**: Because of the screen lengths at Lower Monumental; Little Goose and Lower Granite, it is helpful to fish survival to have a balance of spill amounts between the three projects. Lower Monumental has standard length submersible traveling screens, which are 20 ft long. More fish are able to get under them and end up going through the turbines, resulting in higher fish mortality. Little Goose and Lower Granite has extended length screens, which are about 40 ft long. Less fish are able to get under them
    - **Mechanical Failure**: During the 2003 spill season some of the gates at McNary could not be lifted due to under designed lifting beams. As a result, the gates will have limited usage during the 2004 spill season as further work is performed to remedy the situation.

16. **Flow Forecast**: The Corps reservoir regulators run computer programs that generate flow forecast for the Columbia and Snake Rivers. These can be found on an internal server location https://npr73.nwd-wc.usace.army.mil/NEWWEB/rccweb/RFS/. The mcol.out.text is the forecast on the middle Columbia River. The lsnake.out.text is the forecast on the lower Snake River. CWMS data is used in these calculations. In these documents, you will see QIQF, which stands for discharge, inflow forecast. QRQF stands for river discharge forecast. HFQF is forebay elevation forecast. To know the meaning of the different abbreviations, see CBT user's manual on https://npr71.nwd-wc.usace.army.mil/

17. **SYSTDG Model**: The Corps will be using the SYSTDG model for the first time during the 2004 spill season as an integral part of the spill program. There are several ways the model may be used.
    - We can perform a "forecast" by entering forecasted conditions into the model and see what the TDG levels will be.
    - We can perform a "hind cast" where we can see what the model would say the TDG levels would be if the conditions for a day in the past were entered. These results are compared to the actual operations.
    - We can perform an "optimization" by setting target forebay and tailwater TDG levels and see what spill levels SYSTDG recommends. Since the optimization button is still under development, some of the work would be done in a more manual approach in SYSTDG.
    - We can vary a specific condition and see what the effects are to the TDG levels.

    During the 2004 spill season, we will be using all of these approaches to evaluate the model's usefulness. Based on the experience gained, the Corps will develop a comprehensive report on the model's usefulness with recommendations for improvement. Factors that will be evaluated include effectiveness and accuracy in predicting the gas caps or TDG levels; limitations to the model, areas that further software development is needed, and recommendations for the model's use in the 2005 spill season.